

Reference: 2303221-01 a 69
Order sheet: 22203659

TEST REPORT n. 221.I.2305.645.EN.01

AT THE REQUEST OF:

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CONCERNING:

**SAMPLE: FINISHING PROCESSES ON DIFFERENT
SUBSTRATES**

TEST: ARTIFICIAL WEATHERING

SAMPLES RECEPTION DATE:	16/03/2023
TESTING STARTING DATE:	20/03/2023
TESTING FINISHING DATE:	24/05/2023

Document digitally signed by legal electronic signature.

THIS REPORT CONSISTS OF 26 CONSECUTIVELY NUMBERED PAGES.

The samples object of test in this report will remain at AIDIMME for a period of one month starting from the report issue date. That period having expired, they will be destroyed. Hence, any verification must be made within this time limit.

AIDIMME. METAL-PROCESSING, FURNITURE, WOOD AND PACKAGING TECHNOLOGY INSTITUTE

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1. DESCRIPTION AND IDENTIFICATION OF THE SAMPLE. INSPECTION BEFORE TESTING.

Six sets of samples of different materials in a range of colors. The samples are referenced by the customer as:

MATERIAL	SAMPLE NUMBER	COMPANY REFERENCE	
		COLOR	COLOR CODE
POLYPROPYLENE basic	1	WHITE	4001
	2	ECRU	4003
	3	TORTORA	4004
	4	GRAY	4005
	5	NAVY	4013
	6	ALMOND	4017
	7	PICKLE	4018
	8	MELON	4015
	9	RED	4014
	10	MOSTAZA	4016
	11	BRONCE	4008
	12	BLACK	4002
POLYCARBONATE	13	CRISTAL	4101
	14	FUME	4103
	15	AMBER	4102
	16	OPAQUE WHITE	4105
	17	OPAQUE BLACK	4104
POLYETHYLENE basic	18	WHITE	2001
	19	STEEL	2005
	20	ANTHRACITE	2006
	21	BLACK	2002
	22	ECRU	2003
	23	CREMA	2017
	24	TAUPE	2004
	25	BRONZE	2008
	26	ICE	2101
	27	BEIGE	2007
	28	MODO GREEN	2016
	29	KHAKI	2009
	30	NOTTE BLUE	2018
	31	PURPURA RED	2015
	32	RED	2014
	33	ORANGE	2019

MATERIAL	SAMPLE NUMBER	COMPANY REFERENCE	
		COLOR	COLOR CODE
POLYETHYLENE coated	34	WHITE	3101
	35	STEEL	3105
	36	ANTHRACITE	3106
	37	BLACK	3102
	38	ECRU	3103
	39	TAUPE	3104
	40	MODO GREEN	3116
	41	KHAKI	3109
	42	CREMA	3117
	43	BEIGE	3107
	44	CHAMPAGNE	3115
	45	BRONZE	3108
	46	NAVY	3113
	47	PURPURA RED	3115
	48	RED	3114
	49	ORANGE	3111
ALUMINIUM coated	50	WHITE	5001
	51	BRITISH GRAY	5038
	52	TRAFFIC GRAY	5037
	53	BLACK	5002
	54	ECRU	5003
	55	CREMA	5036
	56	CASTORO FIBER	5035
	57	BRONZE	5033
	58	NOTTE BLUE	5030
	59	MODO GREEN	5032
	60	PICKLE	5020
	61	ALMOND	5019
	62	RED	5014
	63	PURPURA	5031
	64	MELON	5018
	65	MOSTAZA	5016
POLYPROPYLENE coated	66	BLANCO	3101
	67	NEGRO	3102
	68	ANTHRACITE	3106
	69	ROJO	3114



Image 1. Samples of POLYPROPYLENE basic for testing.

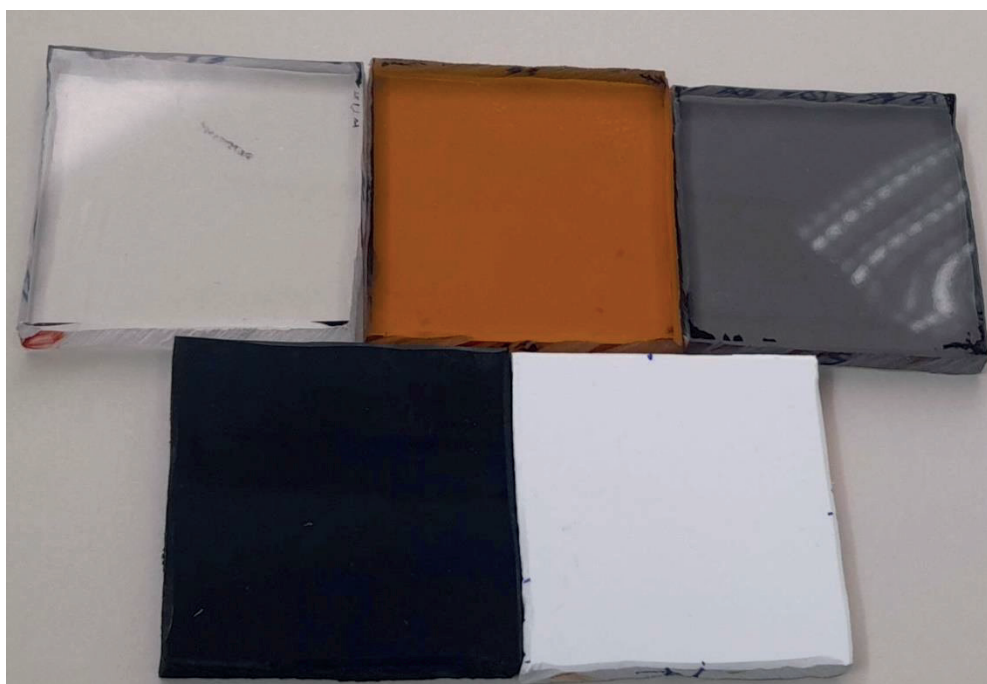


Image 2. Samples of POLYCARBONATE for testing.



Image 3. Samples of POLYETHYLENE basic for testing.



Image 4. Samples of POLYETHYLENE coated for testing.



Image 5. Samples of ALUMINIUM coated for testing.



Image 6. Samples of POLYPROPYLENE coated for testing.

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2. ORIGIN OF THE SAMPLE

Sample supplied by the customer.

3. TESTS REQUESTED

- Artificial weathering with cycles consisting of radiation and spraying, 1000 hours.

4. STANDARD TEST METHOD

Test methods are carried out according to the standards:

- | | |
|--------------------------|---|
| ➤ Artificial weathering. | UNE EN ISO 4892-2:2014 / A1:2022
Method A, cycle 1 |
| ➤ Color measurement. | UNE-EN ISO 18314-1:2019 |

5. DESCRIPTION OF THE TEST METHOD

Artificial weathering

The artificial weathering test has been carried out according to the UNE EN ISO 4892-2 standard (method A. Cycle n°1), in an equipment with xenon lamps, with a combination of radiation and spraying.

The weathering test time has been 1000 hours, under the following test conditions:

- Irradiance: 60 W/m² (300 - 400 nm)
- Filter: Sunlight filter
- Blackbody temperature: 65 ± 3 °C
- Relative humidity: 50 ± 5 %.
- Cycle: 102 minutes of dry radiation +18 minutes of spraying.

After exposure, the appearance of the samples is evaluated (change in colour, gloss, possible surface defects) comparing with a control sample.

Additionally, the color variation is determined by measuring with a colorimeter the color coordinates of each sample, before and after weathering, according to the following method.



Image 7. Samples in the specimen holders.

Color measurement

To define the colour of the samples to be tested, the CIELAB chromatic system is used, which allows to characterise the colours of opaque samples through three chromatic coordinates,

- L^* : indicates lightness (0 black -100 white).
- a^* : chromatic coordinate (red (+ a^*) or green (- a^*)).
- b^* : chromatic coordinate (yellow (+ b^*) or blue (- b^*)).

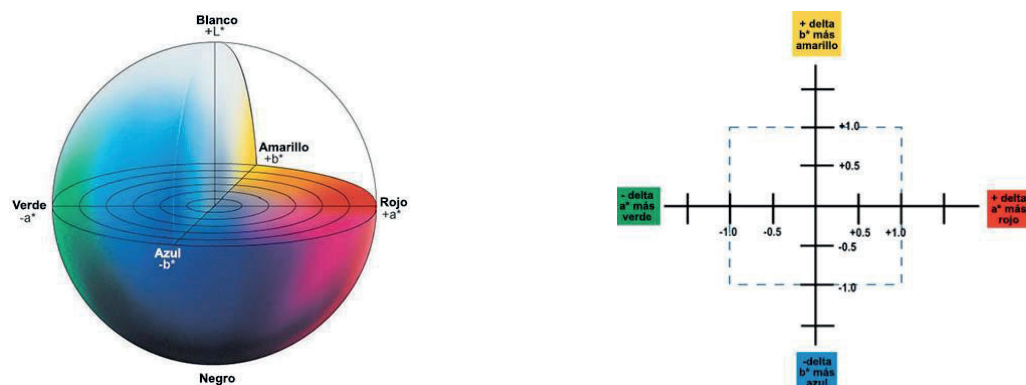


Image 8. Left, chromaticity diagram L^* , a^* , b^* . Right, representation of the meaning of the differences in the chromatic coordinates. Source: Konica Minolta.

After artificial weathering, the colour is measured again at several points on the surface to determine if the exposure to radiation, humidity and temperature changes causes any variation in this property.

The difference between the colour coordinate values before and after the weathering test is calculated:

$$\begin{aligned}\Delta L^* &= L_2^* - L_1^* \\ \Delta a^* &= a_2^* - a_1^* \\ \Delta b^* &= b_2^* - b_1^*\end{aligned}$$

The results obtained indicate whether there has been a change in the samples' colour due to artificial weathering and in what sense:

- ΔL^* (+) clearer sample.
 (-) darker sample.
- Δa^* (+) increase in reddish tonality or decrease in green tonality.
 (-) decrease reddish tonality or increase of green.
- Δb^* (+) increase in yellow tonality or decrease in blue tonality.
 (-) decrease in yellow tonality or decrease in blue tonality.

The total color difference, ΔE , is calculated according to the following formula:

$$\Delta E = \sqrt{\left((L_2 - L_1)^2 + (a_2 - a_1)^2 + (b_2 - b_1)^2\right)}$$

6.2.-DIFFERENCE OF COLOUR AND FINAL APPEARANCE ASSESSMENT (1000 h / 215.984 kJ/m²).

➤ SAMPLE: POLYPROPYLENE BASIC

SAMPLE NUMBER	REFERENCE	DIFFERENCE OF COLOUR				VISUAL ASSESSMENT
		ΔL *	Δa*	Δb*	ΔE	
1	WHITE 4001	-0,37	0,08	-0,03	0,38	Without changes
2	ECRU 4003	0,13	0,05	-0,21	0,25	Without changes
3	TORTORA 4004	0,21	0,05	0,04	0,22	Without changes
4	GRAY 4005	0,09	0,03	-0,05	0,10	Without changes
5	NAVY 4013	0,72	-0,32	-0,05	0,79	Without changes
6	ALMOND 4017	0,30	-0,21	-0,60	0,70	Without changes
7	PICKLE 4018	-0,52	0,40	-0,03	0,65	Without changes
8	MELON 4015	0,33	0,28	-0,20	0,48	Without changes
9	RED 4014	0,87	0,73	0,20	1,15	Without changes
10	MOSTAZA 4016	0,28	-0,09	-0,15	0,33	Without changes
11	BRONCE 4008	0,64	-0,08	-0,22	0,68	Without changes
12	BLACK 4002	1,12	0,05	0,23	1,14	Without changes

➤ **SAMPLE: POLYCARBONATE**

SAMPLE NUMBER	REFERENCE	DIFFERENCE OF COLOUR				VISUAL ASSESSMENT
		ΔL^*	Δa^*	Δb^*	ΔE	
13	CRISTAL 4101	-0,99	-1,31	4,78	5,05	Yellowing and loss of transparency due to surface matting.
14	FUME 4103	-0,90	-0,42	-3,66	3,80	Loss of transparency due to surface matting
15	AMBER 4102	-0,34	-0,78	2,78	2,91	Yellowing and slight loss of transparency due to surface matting.
16	OPAQ. WHITE 4105	2,59	-0,40	-0,63	2,70	Yellowing and matting of the exposed surface.
17	OPAQ. BLACK 4104	-0,81	-1,76	-0,63	2,04	Matting of the exposed surface.

SAMPLE NUMBER	REFERENCE	DIFFERENCE OF COLOUR				VISUAL ASSESSMENT
		ΔL^*	Δa^*	Δb^*	ΔE	
18	WHITE 2001	-0,35	-0,03	-0,74	0,82	Slight colour change only noticeable when compared to control sample
19	STEEL 2005	-0,11	-0,08	-1,16	1,17	Without changes
20	ANTHRACITE 2006	0,86	-0,04	0,05	0,87	Without changes
21	BLACK 2002	-0,27	-0,04	-0,10	0,29	Without changes
22	ECRU 2003	0,09	-0,11	-0,10	0,17	Without changes
23	CREMA 2017	0,18	0,03	-0,18	0,26	Without changes
24	TAUPE 2004	-0,04	-0,05	-0,16	0,18	Without changes
25	BRONZE 2008	0,02	0,10	0,04	0,11	Without changes
26	ICE 2101	1,74	-0,28	1,00	2,02	Without changes
27	BEIGE 2007	0,11	-0,04	-0,04	0,13	Without changes
28	MODO GREEN 2016	0,17	-0,11	0,04	0,20	Without changes
29	KHAKI 2009	0,93	0,54	1,56	1,89	Slight colour change only noticeable when compared to control sample
30	NOTTE BLUE 2018	0,11	-0,19	0,20	0,30	Without changes
31	PURP. RED 2015	0,62	-0,38	-0,28	0,78	Without changes
32	RED 2014	-0,92	-2,48	-1,55	3,07	Without changes
33	ORANGE 2019	-0,26	-0,24	0,16	0,39	Without changes

➤ **SAMPLE: POLYETHYLENE COATED**

SAMPLE NUMBER	REFERENCE	DIFFERENCE OF COLOUR				VISUAL ASSESSMENT
		ΔL^*	Δa^*	Δb^*	ΔE	
34	WHITE 3101	-0,69	0,13	0,17	0,72	Without changes.
35	STEEL 3105	0,37	0,00	0,31	0,48	Without changes. Initial adhesion failure.
36	ANTHRACITE 3106	-0,36	-0,03	0,08	0,37	Without changes. Initial adhesion failure.
37	BLACK 3102	0,14	0,03	-0,03	0,14	Without changes of colour and brightness, but small blisters appear in the centre.
38	ECRU 3103	-0,24	1,17	-0,03	1,20	Without changes. Initial adhesion failure.
39	TAUPE 3104	-0,45	0,11	-2,25	2,29	Without changes.
40	MODO GREEN 3116	-0,59	1,16	0,17	1,31	Slight colour change, only noticeable when compared with the control sample. Initial adhesion failure.
41	KHAKI 3109	0,01	-0,32	-0,88	0,94	Without changes. Initial adhesion failure.
42	CREMA 3117	-1,62	-0,05	0,50	1,69	Without changes.
43	BEIGE 3107	-0,44	0,09	-0,03	0,45	Without changes.
44	CHAMPAGNE 3115	-1,72	0,12	0,27	1,75	Without changes. Initial adhesion failure.
45	BRONZE 3108	-0,02	-0,03	0,14	0,15	Without changes.
46	NAVY 3113	-0,76	0,02	0,52	0,92	Without changes.
47	PURP. RED 3115	-0,22	-0,49	-0,54	0,76	Without changes. Initial adhesion failure.
48	RED 3114	-0,33	-0,37	-0,76	0,91	Without changes. Initial adhesion failure.
49	ORANGE 3111	-0,54	-0,54	-1,23	1,45	Without changes. Initial adhesion failure.

➤ **SAMPLE: ALUMINIUM COATED**

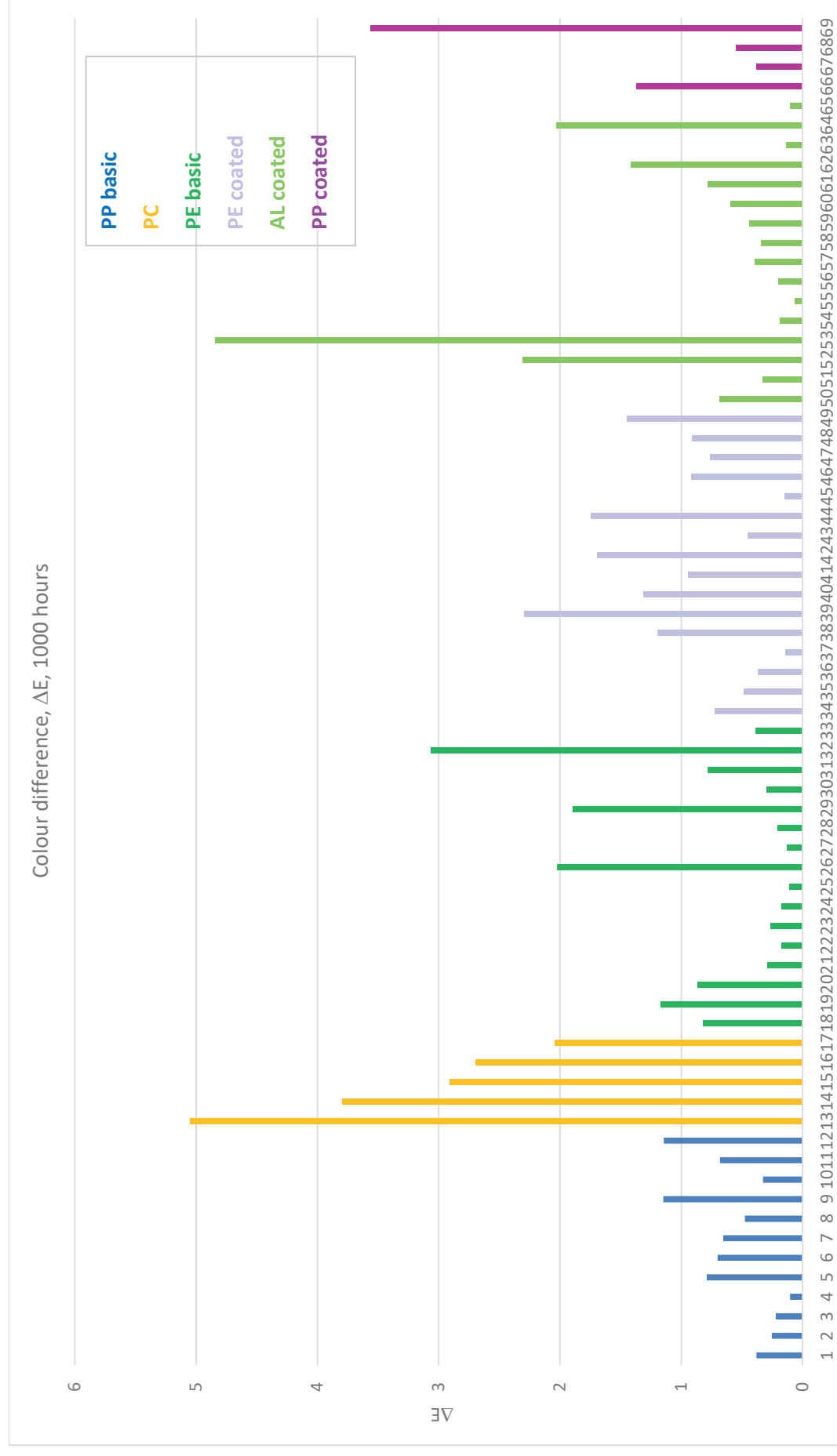
SAMPLE NUMBER	REFERENCE	DIFFERENCE OF COLOUR				VISUAL ASSESSMENT
		ΔL^*	Δa^*	Δb^*	ΔE	
50	WHITE 5001	0,35	0,14	-0,57	0,68	Without changes.
51	BRITISH GRAY 5038	0,30	-0,04	-0,13	0,33	Without changes.
52	TRAFF. GRAY 5037	-0,88	-0,30	2,11	2,31	Very significant change in colour and gloss.
53	BLACK 5002	-4,84	-0,20	0,13	4,85	Very significant change in colour and gloss.
54	ECRU 5003	0,13	-0,01	0,13	0,18	Without changes.
55	CREMA 5036	0,00	0,02	-0,06	0,07	Without changes.
56	CAST. FIBER 5035	0,12	-0,05	-0,15	0,20	Without changes.
57	BRONZE 5033	-0,38	0,05	0,07	0,39	Gloss change
58	NOTTE BLUE 5030	0,02	0,12	0,32	0,34	Gloss change
59	MODO GREEN 5032	0,38	0,06	-0,22	0,44	Gloss change
60	PICKLE 5020	0,40	0,36	-0,25	0,59	Central zone not homogeneous with change of gloss
61	ALMOND 5019	0,01	0,47	-0,62	0,78	Without changes.
62	RED 5014	0,42	1,20	0,62	1,41	Slight change of gloss
63	PURPURA 5031	0,13	-0,03	-0,02	0,14	Slight change of gloss
64	MELON 5018	1,67	-1,15	-0,14	2,03	Slight change of gloss
65	MOSTAZA 5016	0,00	-0,06	-0,08	0,10	Without changes.

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➤ **SAMPLE: POLYPROPYLENE COATED**

SAMPLE NUMBER	REFERENCE	DIFFERENCE OF COLOUR				VISUAL ASSESSMENT
		ΔL^*	Δa^*	Δb^*	ΔE	
66	BLANCO 3101	-1,32	-0,35	-0,10	1,37	Without changes.
67	NEGRO 3102	-0,37	0,07	-0,07	0,38	Without changes.
68	ANTHRACITE 3106	0,49	-0,18	0,17	0,55	Without changes.
69	ROJO 3114	-0,69	-2,92	-1,92	3,56	Slight colour change, only noticeable when compared with the control sample

In the following graph the colour difference, ΔE , of all tested samples is shown.



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The following images show the control replicate and the replicate after 1000 hours of exposure for each of the samples tested.



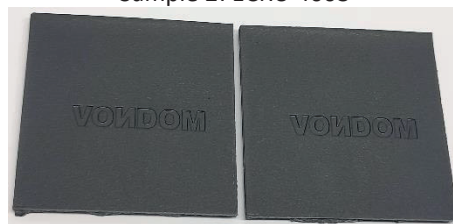
Sample 1: WHITE 4001



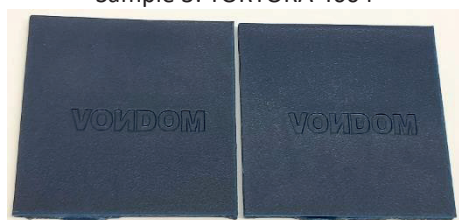
Sample 2: ECRU 4003



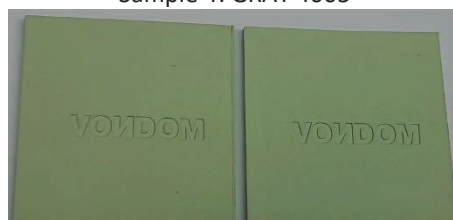
Sample 3: TORTORA 4004



Sample 4: GRAY 4005



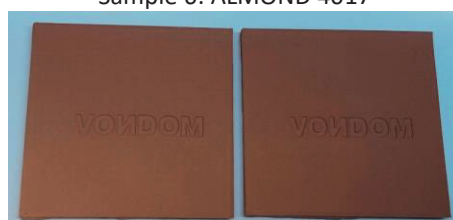
Sample 5: NAVY 4013



Sample 6: ALMOND 4017



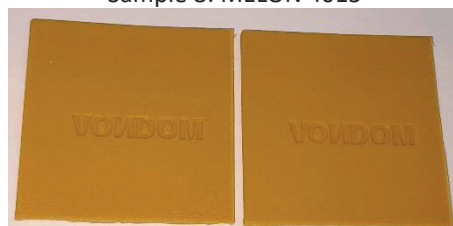
Sample 7: PICKLE 4018



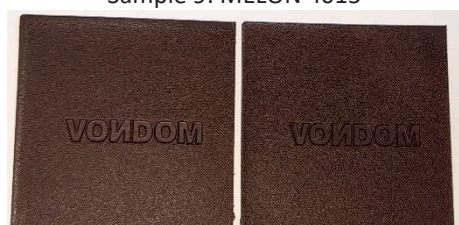
Sample 8: MELON 4015



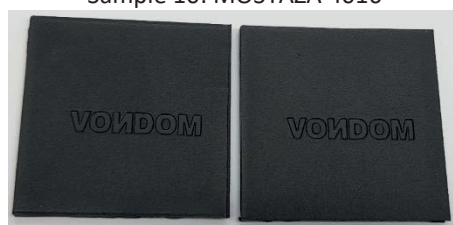
Sample 9: MELON 4015



Sample 10: MOSTAZA 4016

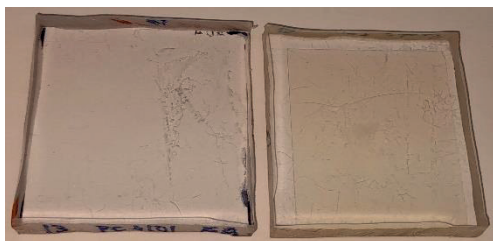


Sample 11: BRONCE 4008



Sample 12: BLACK 4002

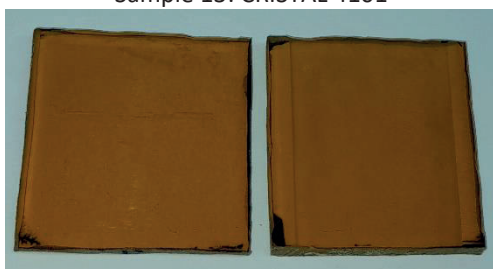
Image 13. BASIC POLYPROPYLENE. In each image, right, control sample, and left, weathered sample.



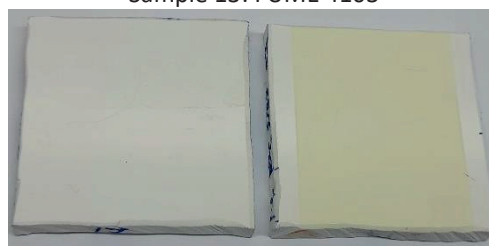
Sample 13: CRISTAL 4101



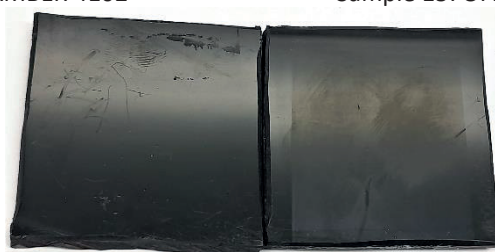
Sample 13: FUME 4103



Sample 14: AMBER 4102



Sample 15: OPAQUE WHITE 4105



Sample 16: OPAQUE BLACK 4104

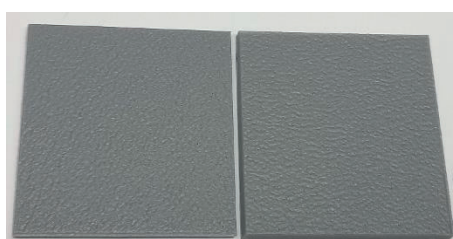
Image 14. POLYCARBONATE. In each image, right, control sample, and left, weathered sample.



Image 15. Detail of matting surface because of weathering.



Sample 18: WHITE 2001



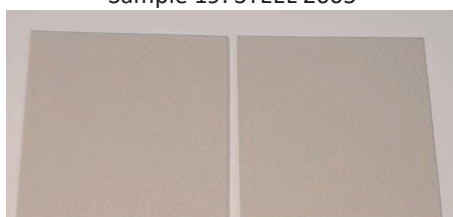
Sample 19: STEEL 2005



Sample 20: ANTHRACITE 2006



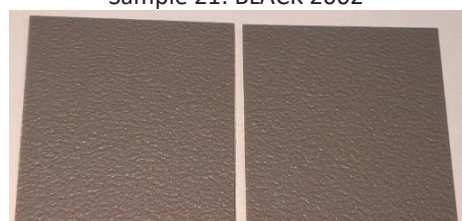
Sample 21: BLACK 2002



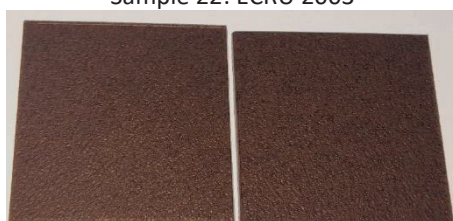
Sample 22: ECRU 2003



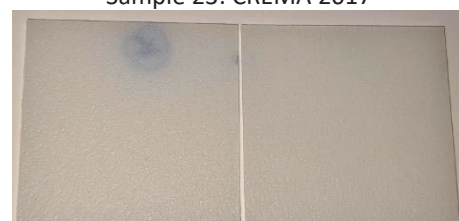
Sample 23: CREMA 2017



Sample 24: TAUPE 2004



Sample 25: BRONZE 2008



Sample 26: ICE 2101



Sample 27: BEIGE 2007



Sample 28: MODO GREEN 2016



Sample 29: KHAKI 2009



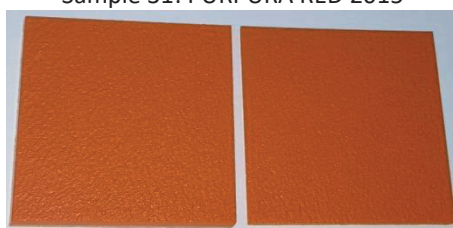
Sample 30: NOTTE BLUE 2018



Sample 31: PURPURA RED 2015



Sample 32: RED 2014

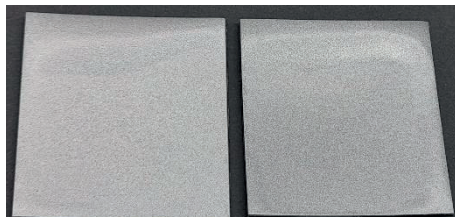


Sample 33: ORANGE 2019

Image 16. POLYETHYLENE BASIC. In each image, right, control sample, and left, weathered sample.



Sample 34: WHITE 3101



Sample 35: STEEL 3105



Sample 36: ANTHRACITE 3106



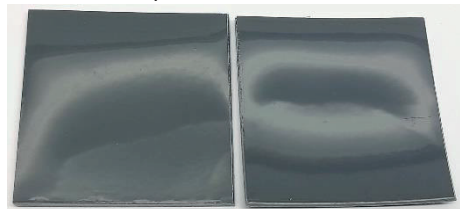
Sample 37: BLACK 3102



Sample 38: ECRU 3103



Sample 39: TAUPE 3104



Sample 40: MODO GREEN 3116



Sample 41: KHAKI 3109



Sample 42: CREMA 3117



Sample 43: BEIGE 3107



Sample 44: CHAMPAGNE 3115



Sample 45: BRONZE 3108



Sample 46: NAVY 3113



Sample 47: PURPURA RED 3115



Sample 48: RED 3114



Sample 49: ORANGE 3111

Image 17. POLYETHYLENE COATED. In each image, right, control sample, and left, weathered sample.



Sample 50: WHITE 5001



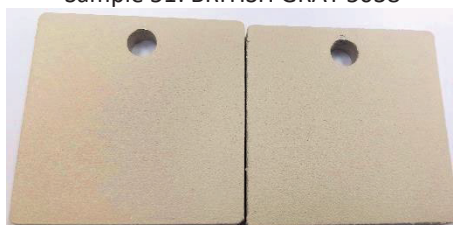
Sample 51: BRITISH GRAY 5038



Sample 52: TRAFFIC GRAY 5037



Sample 53: BLACK 5002



Sample 54: ECRU 5003



Sample 55: CREMA 5036



Sample 56: CASTORO FIBER 5035



Sample 57: BRONZE 5033



Sample 58: NOTTE BLUE 5030



Sample 59: MODO GREEN 5032



Sample 60: PICKLE 5020



Sample 61: ALMOND 5019



Sample 62: RED 5014



Sample 63: PURPURA 5031



Sample 64: MELON 5018



Sample 65: MOSTAZA 5016

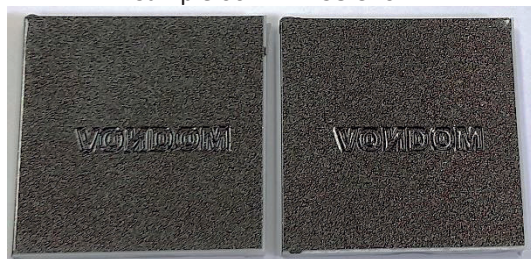
Image 20. ALUMINIUM COATED. In each image, right, control sample, and left, weathered sample.



Sample 66: BLANCO 3101



Sample 67: NEGRO 3102



Sample 68: ANTHRACITE 3106



Sample 69: ROJO 3114

Image 23. POLYPROPYLENE COATED. In each image, right, control sample, and left, weathered sample.

The results of the tests apply only to the tested samples.

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Date: 30th May, 2023

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